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**Studies of the Fishes of the
Order Cyprinodontes**

BY

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STUDIES OF THE FISHES OF THE ORDER CYPRINODONTES

By CARL L. HUBBS

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I. A CLASSIFICATION OF THE FISHES OF THE ORDER

I

The order Cyprinodontes Agassiz (equivalent to Microcyprini Regan) comprises certain fishes which have in the past been more or less confused, first with the Cyprinidae, then later with the Haplomi (*Esox*, *Umbra*, *Dallia*). Toward each of these groups the Cyprinodontes show, indeed, a superficial resemblance, but this resemblance is apparently not indicative of genetic relationship.

It has long been clear that these fishes have no close affinity with the cyprinids, but not until 1911 was their close relationship with the Haplomi critically questioned.¹

It appears probable, in reference to the main line of evolution of fishes, that the Cyprinodontes are of distinctly more advanced organization than the Haplomi. They differ from the Haplomi and most other primitive orders of fishes, and resemble the acanthopterygian fishes in the following respects:

1. The premaxillaries alone form the margin of the upper jaw.
2. The pectoral fin is elevated in position, and the base of the fin is lateral and vertical, rather than ventral and transverse (in *Dallia* alone among the Haplomi the pectoral fin resembles that of the Cyprinodontes, but in that genus the basal bones are highly modified: the resemblance is not indicative of relationship).
3. The pelvic fins are more anteriorly inserted.
4. The pelvic rays are not more than 6 in number.
5. The vertebrae are typically reduced in number.
6. The larval adhesive organ, which the writer has found retained in *Esox lucius* of the Haplomi, is apparently never developed in any of the Cyprinodontes.

¹ Regan, *Ann. Mag. Nat. Hist.*, 7, 1911, p. 323.

7. Finally, a fact perhaps most conclusively indicative of a more advanced organization, the branchiostegal rays of the Cyprinodontes are of the acanthopterygian type, whereas those of the Haplomi are of a distinctly more generalized type.²

II

The writer agrees with Jordan³ that the old family Poeciliidae or Cyprinodontidae should be dismembered. While as a whole Jordan's division of the group seems sound, in certain details it apparently requires modification.

The subfamily Fundulinae is equivalent to the Haplochilinae (properly the Aplocheilinae) of Garman, a name of earlier date. The Orestiidae might better be regarded also as a subfamily (Orestiinae) of the Cyprinodontidae.

The Characodontidae and Goodeidae should not be separated, for to do so would destroy the extreme naturalness of the combined group. The name Characodontinae is synonymous with Goodeinae, which is the older; the family should therefore be named Goodeidae. This family may best be divided into two groups (quite unlike those recognized by Jordan), namely, the Zoogoneticinae (new subfamily name), containing Zoogoneticus and Girardinichthys, and characterized by the simple teeth and short intestine, and the Goodeinae proper, consisting of Characodon, Chapalichthys, Goodea and Skiffia, and characterized by the bicuspid teeth and more or less elongate intestine.

The Poeciliidae (misprinted Poecilidae) may be accepted as outlined by Jordan, except that four generic names listed under this family should be transferred to the Cyprinodontidae. These names follow: Gambusinus, Cynodonichthys, Ilyodon (relationship doubtful) and Cynopoecilus.

The Fitzroyidae and Anablepidae should probably be reduced to subfamily rank, for the latter group was very probably derived from the former. The name Anablepidae holds for the combined group, being the older. The name Fitzroyinae must be altered to Jenynsiinae, according to the international rules as at present interpreted (Fitzroyia and Jenynsia were proposed in the same work by Günther; Fitzroyia has page priority, but the name Jenynsia was accepted by the earlier writers, who regarded the two genera as synonymous).

III

The families of Cyprinodontes may therefore stand as follows:

Cyprinodontidae	Poeciliidae
Adrianichthyidae	Phallostethidae
Goodeidae	Amblyopsidae
Anablepidae	

² See Hubbs, *Jour. Morph.*, 33, 1919, p. 67.

³ A classification of fishes including families and genera so far as known. *Stanford Univ. Publ. (Biol. Sci.)*, 3, 1923, pp. 77-243, i-x.

GONOPODIA OF POECILIIDAE

PLATE III

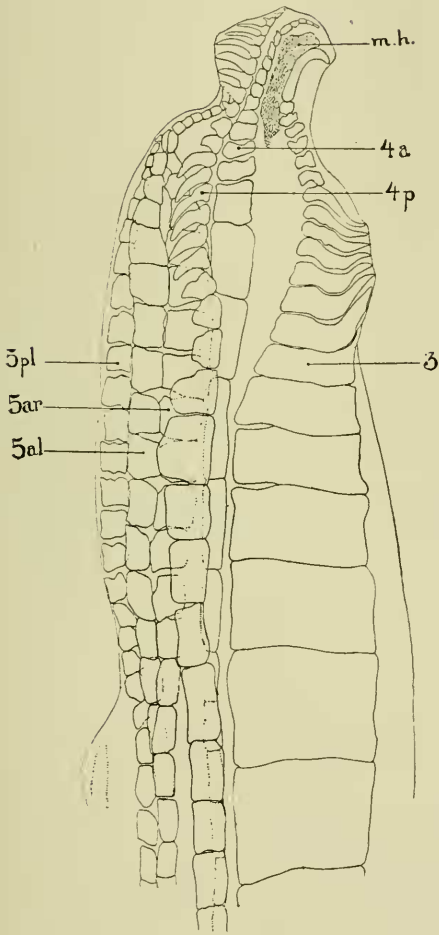


FIGURE 4

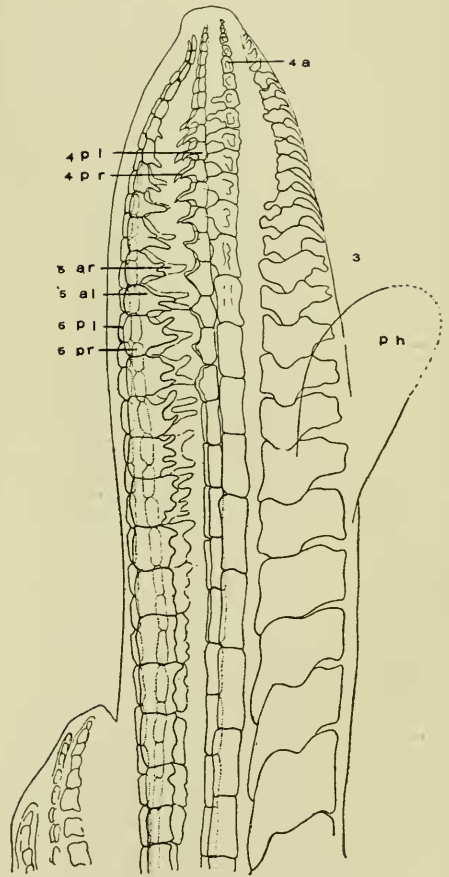


FIGURE 5

PLATE IV

Figure 6. Distal portion of the gonopodium of *Allopoecilia caucana*, from a specimen 26 mm. long to caudal fin, from Rio Camarones at Arcoyo de Arena, Colombia.

Figure 7. Distal portion of the gonopodium of *Mollicnesia latipinna*, from a specimen 51 mm. long, from Louisiana. In figures 6 and 7 the membranous hook is labelled *m h*, the retrorse segment at tip of ray 5, *r s.*

GONOPODIA OF POECILIIDAE

PLATE IV

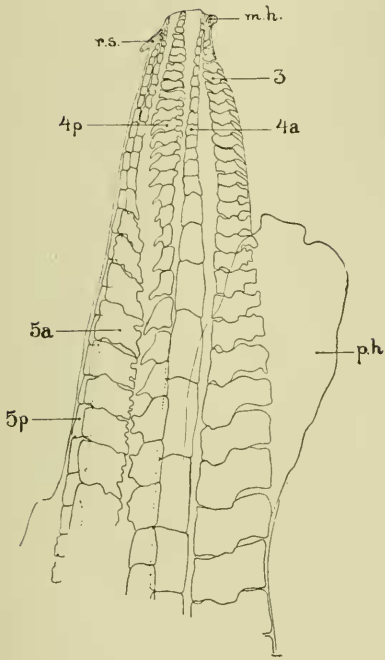


FIGURE 6

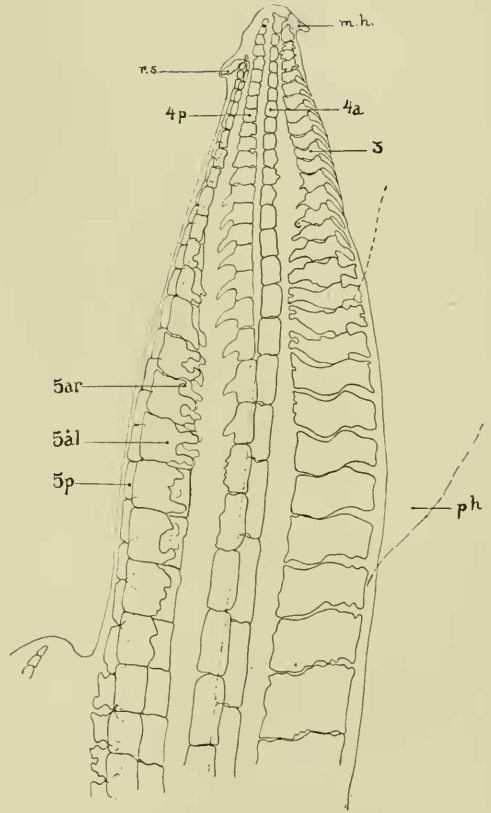


FIGURE 7

II. AN ANALYSIS OF THE GENERA OF THE POECILIIDAE

I

Since 1913, when Regan published *A Revision of the Cyprinodont Fishes of the Subfamily Poeciliinae*,¹—an epoch-making work in the study of this group of tropical American fishes,—a number of new types have been discovered, and new light has been thrown on the characters and relationships of forms previously described. It seems advisable, therefore, to bring this revision by Regan up to date and to include at the same time some original observations and deductions.

As Regan's review demonstrated, by far the most valuable of all the characters which have been used in the classification of these little fishes are those taken from the structure of the gonopodium² (this is the intromittent organ of the male, formed by the elongation and singular elaboration of rays 3, 4 and 5 of the anal fin; see figures). With the aid of gonopodial characters, Regan and other writers have been able to demonstrate repeatedly that species which previously had been closely associated together in reality should be distributed to distant parts of the series, and that species which had been widely separated in the older classifications were, nevertheless, very closely related. In the older systems the characters chiefly used involved the length of the intestine and the shape and arrangement of the teeth, features correlated closely with food, and now known to have been repeatedly and independently altered on the different lines of evolution within the family (these characters still appear to be of high value in the classification of the Poeciliidae, however, even now that it has been shown that they cannot safely be employed in the primary division of the group).

Unfortunately, males are often not taken, even when a considerable series of these fishes are collected, or, if taken, the males may be either young or non-breeding individuals, in either case not showing the characteristic structure of the gonopodium. Unless a species is known and recognized, it cannot be certainly classified in the absence of males with perfect gonopodia; usually even its approximate position in the series cannot be determined. In fact, species of one cyprinodont family known only from females may be, as they have been at various times, placed in genera belonging to another family of the group.

Gonopodia may be quickly mounted on a slide, using preferably the glycerine sodium silicate medium recently described by Creaser and Clench,³ and thus readily studied and drawn with the aid of a microscope, or, better, of a projection apparatus. In routine identification most of the gonopodial features may be made out with the aid of a 12X or 18X hand lens.

¹ Regan, *Proc. Zool. Soc. London*, 1913, pp. 977-1018; figs. 168-173, and pls. 99-101. The Poeciliinae of Regan are equivalent to the Poeciliidae of the present paper.

² Gonopodia were figured and used as systematic characters as early as 1848 (Heckel), 1855 (Poey), and 1907 (Eigenmann), but Regan was the first to use gonopodial characters in a comprehensive revision of the entire group.

³ *Trans. Am. Micr. Soc.*, 42, 1923, pp. 69-71.

II

The gonopodium is the chief distinctive feature of the Poeciliidae (as here delimited). In the other groups of viviparous cyprinodonts the anal fin, to be sure, is also modified as an intromittent organ, but in so different a fashion as to indicate an entirely independent origin as compared with the gonopodium. It is highly probable that the Goodeidae, Poeciliidae and Anablepidae, as well as the remarkable Phallostethidae of the Malay Peninsula, originated independently from the oviparous Cyprinodontidae.⁴ It is, therefore, probable that viviparity has been independently acquired four times among the cyprinodont fishes. If this view is correct, we have in the present case a most striking example of the independent attainment, within one group of animals, of one end through diverse adaptation. The oviparous Cyprinodontidae, it would further follow, have had and probably still possess the potentiality of developing viviparity. In fact, many of the species of this family show an approach toward the viviparous condition in the development of clasping structures and habits.⁵

In the following key to the genera of the Poeciliidae the family is divided into four subfamilies,—the Gambusiinae, Poeciliopsinae, Poeciliinae and Tomeurinae. These groups are of unequal size, but are recognized as coördinate because each appears to have evolved from the basal stock of the whole family, each being characterized by certain primitive as well as specialized features. Of the four subfamilies, the Gambusiinae are without question the least specialized, while Tomeurus is the most highly modified poeciliid.

Within these subfamilies certain clusters of genera may be recognized, by reason of the remarkable coördination which they display between geographical distribution and gonopodial structure, as distinct groups of independent origin. As it is planned to return later to a fuller consideration of these phenomena, it seems desirable to assign definite names to these groups. For this purpose the term *tribe* (with the ending -ini) may be borrowed from entomology.

III

In the key one new subfamily, nine new tribes, nine new genera, and one new species are diagnosed. A list of these new names follows:

New subfamily name: Poeciliopsinae.

New tribe names: Gambusiini,	Xiphophorini,
Heterandriini,	Poeciliini,
Girardinini,	Alfarini,
Cnesterodontini,	Tomeurini.
Pamphoriini,	

New genera: Panamichthys,	Xenophallus,
Allogambusia,	Neopoecilia,
Darienichthys,	Parapoecilia,
Alloheterandria,	Allopoecilia.
Phallichthys,	

New species: *Neopoecilia holacanthus*.

⁴ The major classification of the cyprinodont fishes is considered in the preceding paper of this series.

⁵ See Newman, *Biol. Bull.*, 12, 1907, pp. 314-348, 3 pls. and 22 figs.

IV

AN ANALYSIS OF THE GENERA OF THE POECILIIDAE

- A¹.—Lower edge of caudal peduncle rounded, with a median series of normal scales. Pelvic fins well developed in both sexes, and inserted behind the base of the pectorals.
- B¹.—Pelvic fins alike in the two sexes. Gonopodium elongate; the two halves of posterior branch of ray 5 not separated.
- C¹.—Rays of the gonopodium not imbricated so as to form an enclosed tube, all lying strictly in the same plane (see figures 1, 2, and 4-7). Jaws firmly united (except in *Girardinus*).....*Gambusiinae*.
- D¹.—Terminal segment of ray 3 (of anal fin in male = first prolonged ray of gonopodium) not forming a specialized transverse process.
- E¹.—Ray 5 and posterior branch of ray 4 each with a small, usually retrorse hook at its extremity; anterior branch of ray 4 with a thickened node, which is sharply produced, except in *Belonesox*, to form the "elbow."
(Tribe **Gambusiini**).⁶
- F¹.—Jaws normally formed. Thickened node of ray 4 shorter but more sharply produced, forming a well-defined "elbow" (see figure 1).
- G¹.—Ray 3 without erect spinules; serrae of ray 4 less modified, and wholly apical to elbow; apical processes of rays 4 and 5 scarcely hooked. Dorsal fin more posteriorly inserted (about twice as distant from eye as from base of caudal in female).....*Heterophallus*.⁷
- G².—Ray 3 with erect spinules more or less sharply developed; serrae of ray 4 better developed, in part at least and usually wholly proximad to elbow; apical processes of rays 4 and 5 strongly hooked, except in one subgenus (undescribed). Dorsal fin less posteriorly inserted.....*Gambusia*.
- F².—Jaws produced into a short beak. Thickened node of ray 4 longer and not sharply produced to form a well-defined "elbow"; ray 3 without erect spinules; serrae of ray 4 sharply developed and wholly proximad to thickened node; apical processes of rays 4 and 5 scarcely hooked.....*Belonesox*.
- E².—Ray 5 and posterior branch of ray 4 each without a trace of a retrorse hook at or near the tip, the posterior branch of ray 4 not entering into the distal modification of the gonopodium; the anterior branch of ray 4 not provided with a thickened node, except in *Allogambusia*⁸ (see figure 2).
- H¹.—Ray 3 without a pair of curved, horn-like appendages; ray 5 always smooth on posterior edge. (Tribe **Heterandriini**).⁹
- I¹.—Ray 3 without developed serrae. Teeth conical (slightly compressed in *Heterandria*).
- J¹.—Ray 3 without definite processes of any kind; ray 4 with no trace of an enlarged node resembling the "elbow" of the *Gambusia*.
- K¹.—Rays 4 and 5 contiguous distally, or nearly so, never separated by a notch in the membrane; rays 3 and 4 not together supporting a small knob.
- L¹.—Rays 4 and 5 both entering into the formation of tip of gonopodium.

⁶ *Gambusiini*, new name (as a tribe name).

⁷ Regan, *Ann. Mag. Nat. Hist.*, (8) 14, 1914, p. 66, fig. A. Haplotype, *Heterophallus rachovii* Regan, from Vera Cruz, Mexico.

⁸ The thickened node of ray 4 in *Allogambusia* is probably of independent origin, as the genus does not otherwise especially resemble the *Gambusiini*, and as the node differs in certain details from the "elbow" of the group.

⁹ *Heterandriini* Hubbs, new tribe name.

- M¹.—Gonopodium rather short; ray 4 curved more or less backward at tip.....Brachyrhaphis.
- M².—Gonopodium rather longer and more slender; ray 4 curved forward at tip.
- N¹.—Tip of gonopodium gently recurved; ray 5 evenly and gently curved; serrated segments of ray 4 numerous....Priapichthys.¹⁰
- N².—Tip of gonopodium abruptly curved forward to form a hook-like appendage; ray 5 arched backward behind the few serrae of ray 4.....Panamichthys.¹¹
- L².—Anterior branch of ray 4 alone entering into the formation of the specialized forward-curved tip of the long gonopodium (see figure 2).
- O¹.—Terminal segment of ray 4 greatly elongate; anterior edge of ray 4 roughened, the posterior edge with numerous serrae. Teeth strictly conical, and mouth with a developed lateral gape. Dorsal fin much longer and inserted farther forward than anal. Size of fish moderate. Sexual dimorphism slight.....Pseudoxiphophorus.
- O².—Terminal segment of ray 4 much less notably enlarged; anterior edge of ray 4 smooth, the posterior edge with few serrae (see figure 2). Teeth somewhat compressed, the mouth more strictly transverse. Dorsal fin about equal in size and opposite in insertion to anal. Size minute. Sexual dimorphism sharp.....Heterandria.
- K².—Rays 4 and 5 not contiguous distally, separated by a notch in the membrane; the finely segmented tip of the anterior branch of ray 4 and the elongated terminal segment of ray 3 together supporting a small knob at tip of fin.....Priapella.
- J².—Ray 3 with a short, suberect, curved spur near tip; anterior branch of ray 4 with a much enlarged node somewhat resembling the "elbow" of the Gambusiini.....Allogambusia.¹²
- I².—Ray 3 with developed serrae along its anterior edge; ray 3 without trace of any processes other than the serrae; anterior branch of ray 4 curved forward distally (straight in Alloheterandria), and alone extended to the extreme tip of the gonopodium. Teeth conical or compressed.
- P¹.—Ray 3 abruptly hooked forward and upward at tip; anterior branch of ray 4 slender throughout, and without an enlarged terminal segment; the posterior branch of ray 4 with the serrae weak, few, and widely separated from tip of ray. Teeth conical.....Darienichthys.¹³
- P².—Ray 3 scarcely curved forward at tip.

¹⁰ Priapichthys Regan. Type (as designated by Jordan), *Gambusia annectens*, the only species the gonopodium of which was known to Regan. The other species which have been referred to Priapichthys are not strictly congeneric with *Priapichthys annectens*.

¹¹ Panamichthys Hubbs, new genus. Type species, *Priapichthys panamensis* Meek and Hildebrand (*Pub. Field Mus., Zool.*, 10, 1916, p. 322). One species, *P. panamensis*.

¹² Allogambusia Hubbs, new genus. Type species, *Gambusia tridentiger* Garman, *Mem. Mus. Comp. Zool.*, 19, 1895, p. 89, pl. 4, fig. 10 (*Priapichthys tridentiger* Meek and Hildebrand, *Publ. Field Mus., Zool.*, 10, 1916, p. 320, fig. 6). Two species, *A. tridentiger* Garman and *A. cana* Meek and Hildebrand.

¹³ Darienichthys Hubbs, new genus. Type species, *Gambusia dariensis* Meek and Hildebrand, *Publ. Field Mus., Zool.*, 10, 1913, p. 88 (*Priapichthys dariensis*, Meek and Hildebrand, *ibidem*, 10, 1916, p. 321, fig. 7). One species known, *D. dariensis*.

- Q¹.—Anterior branch of ray 4 with an enlarged terminal segment; posterior branch of ray 4 with the serrae few but strong, extending nearly to tip of ray; serrae of ray 3 short.
- R¹.—Terminal segment of gonopodium not curved, but with a backward directed spinelet; segments of anterior branch of ray 4 everywhere slender. Mouth with a lateral cleft; teeth conical. Size of fish small.....**Alloheterandria**.¹⁴
- R².—Terminal segment of gonopodium strongly curved forward, and without spinelets; two subterminal segments of anterior branch of ray 4 considerably thickened. Mouth vertical; teeth somewhat expanded at tip. Size minute.....**Neoheterandria**.¹⁵
- Q².—Anterior branch of ray 4 with the terminal segment not enlarged; posterior branch of ray 4 with the serrae more numerous, but not nearly extended to tip of ray; serrae of ray 3 long. Teeth incisor-like; mouth without developed lateral cleft.....**Pseudopoecilia**.
- H².—Ray 3 with a pair of curved horn-like appendages near tip; ray 5 with the posterior edge serrate. (Tribe **Girardinini**).¹⁶
- S¹.—Bones of the lower jaw firmly united; the teeth fixed.
- T¹.—Teeth of the outer row spear-shaped and widely spaced....**Toxus**.
- T².—Teeth of outer row chisel-shaped and close-set.....**Glardichthys**.
- S².—Bones of lower jaw loosely connected; teeth of outer row movable, spatulate.....**Girardinus**.
- D².—Terminal segment of ray 3 forming a more or less highly specialized process. (Tribe **Cnesterodontini**).¹⁷
- U¹.—Process not trowel-like.
- V¹.—Process not forked, nor antler-like.
- W¹.—Process short, with a simple and slight curve; ray 3 with serrae on both edges. Teeth of outer row conic.....**Diphyacantha**.¹⁸
- W².—Process inordinately elongate, with a strong, double curve; ray 3 without developed serrae. Teeth of outer row chisel-shaped, followed by a single series of conical teeth.....**Cnesterodon**.
- V².—Process forked, and each fork antler-like. Teeth of outer row oar-shaped, slender, followed by a band of villiform teeth....**Phalloceros**.
- U².—Process trowel-shaped; a most remarkable structure, formed like a relatively immense scoop, with a compressed horn on each side, and attached to the fin by a narrow pedicel. Teeth oar-shaped, in a single series.....**Phallotorynus**.¹⁹
- C².—Rays of the gonopodium imbricated so as to form an enclosed tube on right side of fin (see figure 3).....**Poeciliopsinae**.
- X¹.—Gonopodium without horn-like appendages; ray 4 not forming a hook at its tip.
- Y¹.—All well developed serrae of ray 4 directed backward.

¹⁴ *Alloheterandria* Hubbs, new genus. Type species, *Gambusia nigroventralis* Eigenmann and Henn, *Indiana Univ. Studies*, No. 16, 1912, p. 26 (*Priapichthys nigroventralis* Henn, *Ann. Carn. Mus.*, 10, 1916, p. 115, fig. 3). In addition to *A. nigroventralis*, *Gambusia caliensis* Eigenmann and Henn, in Henn, *l. c.*, p. 113, may prove to belong to this genus.

¹⁵ *Neoheterandria* Henn, *Ann. Carn. Mus.*, 10, 1916, p. 117, fig. 5. Haplotype, *Neoheterandria elegans* Henn, from Colombia.

¹⁶ *Girardinini* Hubbs, new tribe name.

¹⁷ *Cnesterodontini* Hubbs, new tribe name.

¹⁸ *Diphyacantha* Henn, *Ann. Carn. Mus.*, 10, 1916, p. 113, fig. 2. Haplotype, *Diphyacantha chococensis* Henn.

¹⁹ *Phallotorynus* Henn, *Ann. Carn. Mus.*, 10, 1916, p. 126, figs. 8-13. Haplotype, *Phallotorynus fasciolatus* Henn, from Brazil.

- Z¹.—Mouth with a lateral cleft; bones of lower jaw firmly connected; teeth fixed and conical.....Leptorhaphis.
- Z².—Mouth with the cleft transverse and vertical; bones of the lower jaw loosely connected; teeth movable and somewhat compressed.
- a¹.—Body deep and the form not distorted. Dorsal inserted farther forward than anal. Gonopodium longer, reaching nearly or quite to caudal base when depressed; posterior branch of ray 4 not nearly reaching tip of fin.....Phallichthys.²¹
- a².—Body slender, and distorted in form, as usual in *Gambusia*. Dorsal inserted farther back than anal. Gonopodium of moderate length, not reaching caudal base when depressed; posterior branch of ray 4 nearly reaching tip of fin.....Poeciliopsis.²²
- Y².—Well developed serrae of ray 4 directed forward and outward in part. Other characters as here given for Poeciliopsis.....Phalloptychus.
- X².—Gonopodium with two prominent horn-like appendages,—one, like the excrescence on a pelican's bill, on the front edge of ray 3; the other a long curved horn attached at base to posterior edge of ray 4. Other characters as here given for Leptorhaphis.....Xenophallus.²³
- B².—Pelvic fins enlarged and modified in the male, the first ray with a soft swollen tip, the second ray thickened and usually much elongated. Ray 5 of anal fin in male (the last ray of the gonopodium) forming a trough posteriorly, the two sides of the posterior branch of the ray being widely separated, and more or less twisted to one side; ray 3 with a membranous swelling along anterior margin (characters not known for the Pamphoriini).....Poeciliinae.
- b¹.—Gonopodium elongate, about one-third as long as the body. Bones of the lower jaw more firmly united. Inner ventral rays abruptly shorter than the second ray. (Tribe Pamphoriini.)²⁴
- c¹.—Teeth of outer series slender, pointed; bones of lower jaw firmly united.....Pamphorichthys.
- c².—Teeth of outer series broad incisors; bones of lower jaw somewhat less firmly united.....Pamphoria.
- b².—Gonopodium short. Bones of lower jaw loosely united. Teeth of outer series rather slender, spatulate.
- d¹.—Membranous swelling on front of gonopodium not forming a definite prepuce-like hood; ray 3 ending in a very large and strong hook, about the end of which the tip of the anterior branch of ray 4 is curved; posterior branch of ray 4 with serrae both distal and proximal to tip of ray 5; ray 5 arched backward toward tip (see figure 4). Inner rays of ventral of male not abruptly shorter than the second ray. (Tribe Xiphophorini.)²⁵
- e¹.—Ray 5 not ending in a hook. Caudal alike in the two sexes; dorsal fin shorter, with 9 to 11 rays.....Platyopocilus.
- e².—Ray 5 ending in a backward-directed hook. Lower rays of caudal fin in the male ending in a long, sword-like appendage; dorsal fin longer, with 13 to 15 rays.....Xiphophorus.

²⁰ Poeciliopsinae Hubbs, new subfamily name.

²¹ Phallichthys Hubbs, new genus. Type species, *Poeciliopsis isthmensis* Regan. *Poeciliopsis isthmensis* from Panama and *Pocillia pittieri* Meek from Costa Rica are probably identical with *Poeciliopsis amates* Miller, from Guatemala and Honduras (a specimen from Tela, Honduras, is at hand).

²² Poeciliopsis Regan. Type, *Pocillia presidionis* Jordan and Culver (as designated by Henn, 1916; not *Poeciliopsis isthmensis* as designated by Jordan, 1920).

²³ Xenophallus Hubbs, new genus. Type species, *Gambusia umbratilis* Meek, *Publ. Field Mus., Zool.*, 10, 1912, p. 70 (type material, from Costa Rica, re-examined).

²⁴ Pamphoriini Hubbs, new tribe name. This tribe perhaps belongs in the Gambusiinae, the distinctive features of its two genera not being well known.

²⁵ Xiphophorini Hubbs, new tribe name.

- d².—Membranous swelling along anterior margin of gonopodium modified into a prepuce-like hood; ray 3 with at most a very small hook; ray 4 straight or nearly so, with serrae only proximal to end of ray 5; ray 5 not arched backward (see figures 5-7). Inner ventral rays abruptly shorter than the second ray. (Tribe **Poeciliini**).²⁶
- f¹.—Ray 5 with the last segment of the posterior branch not elongate, nor sharply retrorse (see figure 5).
- g¹.—Tips of all rays very slender; ray 3 with either serrae or a terminal hook.
- h¹.—Ray 3 serrate along anterior margin, not abruptly nor extensively slender at tip, and without a trace of a terminal hook.
- i¹.—Anterior branch of ray 4 strictly entire on both margins; anterior edge of ray 5 more or less roughened, but hardly spinous. **Poecilia**.
- i².—Both branches of ray 4 serrate on posterior margin; anterior edge of ray 5 with long spines (see figure 5) **Neopoecilia**.²⁷
- h².—Ray 3 without developed serrae, and abruptly narrowed distally to form a long, slender tip, which bears a terminal hook. **Limia**.
- g².—Tip of ray 3 and of posterior branch of ray 4 markedly clavate; ray 3 lacking both serrae and terminal hook. **Parapoecilia**.²⁸
- f².—Ray 5 with the last segment of the posterior branch elongate and abruptly retrorse, entering the posterior profile of the gonopodium (see figures 6 and 7).
- j¹.—Ray 3 without processes on posterior margin; terminal hook of same ray weakly or not at all developed. Fishes of minute size.
- k¹.—Tips of all the rays of the gonopodium slender; anterior as well as posterior branch of ray 4 serrate on posterior margin; serrae of ray 3 strong; terminal hook of ray 3 wholly undeveloped. Sexual dimorphism in color and size strongly marked. **Lebistes**.
- k².—Tips of ray 3 and of posterior branch of ray 4 clavate (but less so than in **Parapoecilia**); posterior branch only of ray 4 serrate; serrae of ray 3 weak; terminal hook of ray 3 often weakly developed (see figure 6). Sexual dimorphism slight. **Allopoecilia**.²⁹
- j².—Ray 3 with long, more or less spinous processes on posterior margin; terminal hook of same ray always strongly developed; tips of all the rays slender; posterior branch only of ray 4 serrate; serrae of ray 3, strong (see figure 7). Larger fishes, with sexual dimorphism slightly marked (except in the development of the dorsal fin) **Mollienisia**.
- A².—Lower edge of the caudal peduncle sharp, without a median series of scales. Pelvic fins better developed in the male sex. Bones of lower jaw firmly united; teeth conical **Tomeurinae**.
- l¹.—Pelvic fins well developed in both sexes, located behind the base of the pectoral fins. Gonopodium very simple in structure, without appendages or serrae; ray 3 with knob-like enlargement. Body rather deep. (Tribe **Alfarini**)³⁰ ... **Alfaro**
- l².—Pelvic fins absent in female, minute and below gill opening in male. Gonopodium with long appendages. Body elongate (tribe **Tomeurini**)³¹ ... **Tomeurus**.

²⁶ Poeciliini Hubbs, new name (as a tribe name).

²⁷ Neopoecilia Hubbs, new genus. Orthotype, *Neopocilia holacanthus* Hubbs, new species (based on the material recorded as *Poecilia vivipara* by Evermann and Marsh, in *Bull. U. S. Fish Comm.*, 1900 (1902), p. 97).

²⁸ Parapoecilia Hubbs, new genus. Type species, *Limia hollandi* Henn, from Brazil (Henn, *Ann. Carn. Mus.*, 10, 1916, p. 138, fig. 17).

²⁹ Allopoecilia Hubbs, new genus. Type species, *Girardinus caucanus* Steindachner (*Mollienisia caucana* Henn, *Ann. Carn. Mus.*, 10, 1916, p. 136, fig. 16).

³⁰ Alfarini Hubbs, new tribe name.

³¹ Tomeurini Hubbs, new name as a tribe name.

III. THE SPECIES OF PROFUNDULUS, A NEW GENUS FROM CENTRAL AMERICA

I

Profundulus, new genus

Orthotype, *Fundulus punctatus* Günther

Several closely related species from Central America, hitherto referred to *Fundulus*, *Adinia*, or *Zoogoneticus*, comprise a natural group, differing from *Fundulus* as here restricted in several important respects.

The lateral rims of the genital aperture of the adult female are scarcely produced, surrounding not more than the first anal ray: thus not forming the genital pouch diagnostic of *Fundulus*. The anal fin in the adult male is lower, instead of higher, than in either the young or the adult female.

The dorsal and anal fins are relatively long and low, the anal especially being composed of more rays (13-17) than usual in *Fundulus*. The two fins are inserted far posteriorly, and near the same vertical, somewhat as in a pike.

The interorbital is more convex, the head being formed more like that of an *Umbra* than that of a *Fundulus*.

In the absence of a genital pouch, at least, the species of *Profundulus* resemble those¹ comprising the African group *Nothobranchius*² (*walkeri*, *orthonotus*, *melanospilus*, *neumanii*, *guentheri*, *taeniopygus*, and possibly others, such as *sjoestedti* and *microlepis*). All of these African types, however, have a much narrower preorbital.

Another African species, commonly referred to *Fundulus*, namely, *capensis*, has the dorsal fin more advanced in position than in *Profundulus*, while the remainder³ have higher and sharper vertical fins, and mouths of different structure.

II

As the more generalized members of *Fundulus*, *Cynolebias* and some other American genera of the Cyprinodontidae, as well as the less specialized Goodeidae, resemble the species of *Profundulus* in habitus, it seems not improbable that *Profundulus*, of all American genera, diverges least from a general ancestral cyprinodont type. The geographical distribution of the groups in question harmonizes with such a view.

¹ For descriptions, figures and references, see Boulenger, *Cat. Fresh-water Fishes of Africa*, 3, 1915, pp. 23-29.

² Recognized by Regan (*Ann. Mag. Nat. Hist.*, 7, 1911, p. 324) as distinct from *Fundulus*.

³ *Fundulus nisorius* Cope, described as from West Africa, is excluded from present consideration, as it was probably based on American material erroneously labelled.

III

Four or more species of *Profundulus* may be distinguished. Two are from the Atlantic, the others from the Pacific drainage of Central America.

1. *Profundulus punctatus* Günther

Fundulus punctatus Günther, Cat. Fishes Brit. Mus., 6, 1866, p. 320 (original description; page priority over *guatemalensis*); Trans. Zool. Soc. London, 6, 1868, p. 482, pl. 84, fig. 5 (redescription of types, with figure); Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 637 (after Günther); Meek, Publ. Field Mus. (Zool.), 5, 1904, p. 104; *ibid.*, 7, 1907, p. 136; Regan, Biol. Centr. Am., Pisces, 1907, p. 78 (excepting *oaxacae* in synonymy); Fowler, Proc. Acad. Nat. Sci. Phila., 68, 1916, p. 47.

Fundulus guatemalensis Günther, Cat. Fishes Brit. Mus., 6, 1866, p. 321 (original description); Trans. Zool. Soc. London, 6, 1868, p. 482, pl. 84, figs. 3, 4 (redescription of types, with figures); Meek, Publ. Field Mus. (Zool.), 5, 1904, p. 103; *ibid.*, 7, 1907, pp. 136, 184.

?*Fundulus guatemalensis* Eigenmann, Proc. U. S. Nat. Mus., 13, 1891, p. 64 (Western Ecuador; locality probably erroneous).

Adinia guatemalensis Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 660 (*punctatus* was here retained in *Fundulus*!).

Zoogoneticus guatemalensis Meek, Publ. Field Mus. (Zool.), 3, 1903, p. 94 (name only; the species erroneously and uncritically placed in the unrelated new genus *Zoogoneticus*).

Fundulus pachycephalus Günther, Cat. Fishes Brit. Mus., 6, 1866, p. 321 (a doubtful synonym of *punctatus*, which has page priority); Trans. Zool. Soc. London, 6, 1868, p. 483, pl. 84, fig. 6 (type figure and redescription of type); Regan, Biol. Centr. Am., Pisces, 1907, p. 77.

Fundulus parvipinnis Garman, Mem. Mus. Comp. Zool., 19, 1895, p. 100 (in part: *Profundulus punctatus* confused with *Fundulus parvipinnis*!).

Specimens collected by George P. Engelhardt in the Rio de Moka, Guatemala, were identified with this species by Dr. S. E. Meek, but the record was never published. All of the material published on by Dr. Meek (see synonymy) has been re-examined. I provisionally follow Regan in uniting the nominal forms *guatemalensis* and *punctatus* under one specific name. The specimens at hand from (the outlet of) Lake Amatitlan, regarded by Meek as typical of *guatemalensis*, are, it is true, of stouter build and paler coloration than stream specimens (typical *punctatus*). But some of the specimens from the outlet of the lake show evident, though indistinct, spots on the dorsal and caudal fins, and closely resemble the type of *punctatus* in the form and general coloration of the body. The degree of spotting is also very variable in stream specimens. Hence it is provisionally assumed that the name *guatemalensis* was based on well-nourished, pale-colored lake specimens of *punctatus*, and that the form is at most only racially distinct.

Counts and Measurements of *Profundulus punctatus*

Locality	San Jose de Idolo,			Masatenango,			Outlet of Lake Amatitlan					
	Guatemala	Guatemala	Guatemala	Guatemala	Guatemala	Guatemala	Guatemala	Guatemala	Guatemala			
Scales: long.	34	33	33	34	34	32	34	33	34	33	34	32
Scales: trans. ⁴	12	12	12	12	12	12	12	12	11	12	12	12
Fin-rays, dorsal	13	11	12	12	12	12	12	11	11	10	12	13
Fin-rays, anal	14	14	15	14	15	14	13	14	13	14	13	15
Length, mm.	57	51.5	57	62	60	42	45	48	54	65	68	72
Depth, body	3.6	3.3	3.5	3.6	3.4	3.4	3.2	3.1	3.4	3.6	3.25	3.4
Origin of dorsal to base of caudal...	2.8	2.65	2.85	2.9	2.75	2.9	2.7	2.95	2.85	2.75	2.85	2.65
Length, head	3.7	3.65	3.35	3.7	3.75	3.3	3.3	3.35	3.5	3.4	3.5	3.4
Length, eye	4	4.1	4	4.2	4.3	4	4	4.1	4.1	4.3	4.6	4.6
Length, snout	3.3	3.4	3.1	3.35	3.4	3.4	3.4	3.2	3.5	3.1	3.2	3.3
Width, interorbital	2.2	2.25	2.2	2.25	2.2	2.2	2.2	2.3	2.25	2.3	2.2	2.2
Width, preorbital	3.6	3.3	3.2	3.6	3.6	3.3	3.4	3.3	3.6	3.2	3.5	3.3
Width, head	1.25	1.5	1.35	1.4	1.3	1.3	1.4	1.35	1.45	1.35	1.35	1.35

⁴ The transverse scale count in *Profundulus* is taken from the base of the pelvic fin directly upward to and including the mid-dorsal series.

2. *Profundulus oaxacae* Meek

Fundulus oaxacae Meek, Publ. Field Mus. (Zool.), 3, 1902, p. 90 (original description); *ibid.*, 5, 1904, p. 104, fig. 28 (redescription and figure of type material).

Fundulus punctatus Regan, Biol. Centr. Am., Pisces, 1907, p. 78 (in part).

As also in *P. labialis* and *P. punctatus*, the anal fin is higher in the female than in the male; it is also high in the young, as in *punctatus*.

Re-examination of Dr. Meek's types from Oaxaca seems to confirm the validity of his species. It is a smaller fish than *punctatus*, and the eye is smaller than in specimens of the Guatemalan species of comparable size (see measurements of each). The scales average fewer in the longitudinal series, but more in the transverse series. The dorsal and anal fins are nearly unicolor, whereas in *punctatus* these fins have a light marginal band, just within which the dark pigment is intensified. The two species, however, are very closely related, and may prove identical (as Regan has held after examining more abundant material).

Counts and Measurements of *Profundulus oaxacae*

Locality, Oaxaca, Mexico

Scales: long. ⁵	31 ⁶	30	31	32	33	31
Scales: trans. ⁷	13	13	13	12	12	13
Fin-rays, dorsal	12 ⁸	11	12	11	11	11
Fin-rays, anal	15	13	14	13	13	13
Length, mm.	48	47	44	43	43	39
Depth, body	3.65	3.4	..	3.6	3.8	3.3
Origin of dorsal to base of caudal..	2.85	2.9	3.0	3.0	2.9	2.85
Length, head	3.7	3.5	3.4	3.4	3.5	3.4
Length, eye	4.7	4.7	4.6	4.5	4.5	4.0
Length, snout	3.35	3.2	3.4	3.5	3.6	3.4
Width, interorbital	2.2	2.3	2.4	2.35	2.4	2.3
Width, preorbital	3.5	3.6	3.7	3.4	3.7	3.6
Width, head	1.45	1.5	1.5	1.4	1.6	1.5

3. *Profundulus candalarius*, new species

Holotype, a male specimen 73 mm. long to base of caudal; collected with a female paratype of 68 mm. in a limestone spring at Candalaria, near the Mexican boundary of Guatemala, 6 leagues distant from Nenton, on June 1, 1906. This is in the basin of the Rio Chiapas of the Atlantic drainage. The specimens were collected by Mr. O. F. Cook, and both are deposited in the Field Museum of Natural History.

P. candalarius in general appearance is similar to *P. labialis* Günther, the only species hitherto known in the Atlantic drainage, it having been taken from Lake Yzabal and from the basin of the Rio Chisoy, tributary thereto.

⁵ In five others: 30, 30, 31, 32, 32.

⁶ Holotype.

⁷ In five others: 12, 12, 12, 13, 13.

⁸ Miscalculated 14 in original description.

From *labialis*, *candalarius* differs in the number of fin-rays and scales, in which characters it agrees with the Pacific species (*punctatus* and *oaxacae*). From these two species *candalarius* differs in form and proportions, as noted in the course of the following description.

In its form *Profundulus candalarius* suggests a pike. The back is heavy at the shoulders, but flat in profile back to the posteriorly inserted dorsal fin. The top of the head is flatter than in related species, both transversely and longitudinally; the anterior profile is a little incurved. The snout is rather more produced and pointed than in the Pacific species. Depth of body, 3.4 (3.5) in total length, minus the caudal; least depth of caudal peduncle, 2.3 (2.2) in head, 1.35 (1.6) in its length from anal fin. Length of head, 3.25 (3.6); eye, 4.5 (4.5), larger than in the species of the Pacific drainage; upper jaw, 3.2 (3.6), not reaching to below eye; least preorbital width, 2.7 (2.8) in postorbital length of head, decidedly wider than in *punctatus* and *oaxacae*. The body and the head are much more compressed than in the species just named: greatest width of head, 1.65 (1.7) in its length; least interorbital width, 2.5 (2.5). Branchial aperture free to upper opercular angle. Gill-rakers only about as long as the pupil, 15 (16) on the lower limb of the outer arch. Teeth in rather broad bands in the jaws, the outer series a little enlarged.

Scales larger than in *P. labialis*, in 33 (35) rows from branchial aperture to caudal base, 12 (13) longitudinal rows from pelvic fin to and including the mediiodorsal series.

Fin rays: dorsal, 12 (12); anal, 14 (15); pelvic, 6 (developed rays). Dorsal fin set farther backward than in *punctatus* and *oaxacae*, the interval between its origin and the caudal base being contained 3.2 (3.2) times in the total length without caudal, rather than from 2.65 to 3.1 times. In the male holotype the dorsal fin is just as high as long, the anal a little longer than high; in the female specimen the dorsal is a little higher than long, while the two dimensions of the anal are about the same. The broad caudal is truncate behind; the pectoral is broadly rounded; the pelvic short, not nearly reaching to anus. The intestine is little coiled.

The coloration is not very distinctly preserved. The scales of the male type are light where exposed, but marked by dark crescents at their bases; dark streaks are evident between each of the longitudinal scale rows. There is a dark axillar blotch. The fins are not distinctly marked; the anal probably had a light margin. The female specimen is rather plainly colored, the scales marked by dark reticulations; an indistinct dark lateral streak was apparently developed; coloration of fins as in the male.

IV. THE SUBSPECIES OF *PSEUDOXIPHOPHORUS BIMACULATUS*
AND OF *PRIAPICHTHYS ANNECTENS*

I

Two species of cyprinodont fishes from Middle America exhibit geographical variation sufficiently well defined and extensive as to require division into subspecies. These species are *Pseudoxiphophorus bimaculatus* of southern Mexico and Guatemala, and *Priapichthys annectens* of Costa Rica.

II

Pseudoxiphophorus bimaculatus Heckel

This species, which inhabits the Atlantic drainage from central Mexico to Guatemala, comprises a complex of races distinguished only by average, intergrading characters. Provisionally it may be divided into three subspecies, two of which have been regarded as distinct species. Of these subspecies, the typical *bimaculatus* is intermediate, the two extreme subspecies being *P. b. taeniatus* Regan and *P. b. jonesii* Günther. These subspecies form a series grading from *jonesii* of the higher mountain streams and lakes of east-central Mexico through the intermediate *bimaculatus* of the lower and somewhat warmer waters back of Vera Cruz into the more southern form.

The characters which distinguish these subspecies are those of form and proportions, color, and, particularly, the number of dorsal rays. From extreme *taeniatus* to *jonesii*, that is, toward the north and toward higher elevations, the body becomes deeper, the head longer, the color paler, the dorsal rays reduced in number. The difference in the number of dorsal rays is summarized in the following table:

Frequency table.—Number of dorsal rays in the three subspecies of *Pseudoxiphophorus bimaculatus*:

	Number of dorsal rays						
	11	12	13	14	15	16	17
<i>P. b. jonesii</i>	15	51	9	6	3	..	..
<i>P. b. bimaculatus</i>.....	..	1	29	21	3	..	..
<i>P. b. taeniatus</i> ¹.....	..	..	..	7	13	4	1

The correlations of these variational phenomena will be considered by the writer in a subsequent paper.

Pseudoxiphophorus bimaculatus jonesii Günther

Mollicnesia jonesii Günther, Ann. Mag. Nat. Hist., (4) 14, 1874, p. 371; Garman, Mem. Mus. Comp. Zool., 19, 1895, p. 52; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 698.

Gambusia jonesii Regan, Ann. Mag. Nat. Hist., (7) 19, 1907, p. 260; Biol. Centr. Am., Pisces, 1907, p. 97, pl. 12, fig. 8.

Pseudoxiphophorus jonesii Regan, Proc. Zool. Soc. London, 1913, p. 993.

¹ Miller, in recording specimens from Guatemala, gave the dorsal rays as 10 to 17, but no one else has found fewer than 14 rays in the dorsal fin of any specimen of this species found so far south. Perhaps Miller confused some other species with the present one.

Pseudoxiphophorus bimaculatus Woolman, Bull. U. S. Fish. Comm., 14, 1894, p. 65; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 678; Meek, Publ. Field Mus., Zool., 5, 1904, p. 127 (in part).

Pseudoxiphophorus pauciradiatus Regan, Ann. Mag. Nat. Hist., (7) 13, 1904, p. 256; (7) 16, 1905, p. 362.

The pertinence of *Molliensia jonesii* to the present genus and its approximate identity with his own *pauciradiatus* has already been indicated by Regan.

The material of this form examined is part of that recorded by Woolman (1894), as *Pseudoxiphophorus bimaculatus*, from the Rio Blanco at Orizaba. This is the type locality of *pauciradiatus*.

Pseudoxiphophorus bimaculatus bimaculatus Heckel

Xiphophorus bimaculatus Heckel, Sitz. Akad. Wiss. Wien, 1, 1848, p. 296, pl. 9, figs. 1, 2.

Pseudoxiphophorus bimaculatus Bleeker, Ichth. Arch. Ind. Prodr., Cypr., 2, 1860, p. 485; Atl. Ichth., 3, 1863, p. 140; Troschel, in Müller's Reise Mexico, 3, App., 1865, p. 104; Günther, Cat. Fishes Brit. Mus., 6, 1866, p. 332; Garman, Mem. Mus. Comp. Zool., 19, 1895, p. 81, pl. 3, fig. 6, and pl. 8, fig. 9; Bean, Proc. U. S. Nat. Mus., 21, 1898, p. 541; Meek, Publ. Field Mus., Zool., 3, 1902, p. 98; Regan, Ann. Mag. Nat. Hist., (7) 13, 1904, p. 256; Meek, Publ. Field Mus., Zool., 5, 1904, p. 127 (in part); Regan, Proc. Zool. Soc. London, 1913, p. 993, fig. 170C (in part); Cockerell, Proc. Biol. Soc. Wash., 28, 1915, pp. 153, 156.

Gambusia (Pseudoxiphophorus) bimaculata Regan, Ann. Mag. Nat. Hist., (7) 19, 1907, p. 260.

Gambusia bimaculata Regan, Biol. Centr. Am., Pisces, 1907, p. 98 (in part).

(?) *Poccilioides bimaculatus* Steindachner, Sitzb. Akad. Wiss. Wien, 48, 1863, p. 176, pl. 4, fig. 2; Troschel, in Müller's Reise Mexico, 3, App. 1865, p. 104 (not *Xiphophorus bimaculatus* Heckel).

Pseudoxiphophorus reticulatus Troschel, in Müller's Reise Mexico, 3, App., 1865, p. 104; Günther, Cat. Fishes Brit. Mus., 6, 1866, p. 333.

The typical subspecies of *Pseudoxiphophorus bimaculatus* inhabits the streams back of Vera Cruz, chiefly at moderate elevations.

In material collected by Meek the dorsal rays vary as indicated in the following table:

Frequency table.—Dorsal rays in *Pseudoxiphophorus bimaculatus bimaculatus*:

	Dorsal rays			
	12	13	14	15
San Francisco River basin at Xico and Jalapa.....	1	24	9	2
Blanco River basin at Cordoba.....	..	1	10	1
Papaloapan basin at Obispo, Perez and El Hule.....	..	4	2	..

Pseudoxiphophorus bimaculatus taeniatus Regan

Pseudoxiphophorus bimaculatus Meek, Publ. Field Mus., Zool., 5, 1904, p. 127 (in part); Regan, Ann. Mag. Nat. Hist., (7) 16, 1905, p. 363; Miller, Bull. Am. Mus. Nat. Hist., 23, 1907, p. 105 (in part?); Regan, Proc. Zool. Soc. London, 1913, p. 993, fig. 170C (in part).

Gambusia bimaculata Regan, Biol. Centr. Am., Pisces, 1907, p. 98 (in part).

Pseudoxiphophorus bimaculatus var. *taeniatus* Regan, Ann. Mag. Nat. Hist., (7) 16, 1905, p. 363; Biol. Centr. Am., Pisces, 1907, p. 98, pl. 14, fig. 4.

The name *taeniatus* was proposed by Regan, as a "variety," to distinguish a form from San Domingo de Guzman, southern Mexico, the distinctive features as pointed out being the development of a median longitudinal stripe and a higher number of dorsal rays. Since the color feature will probably prove to be only a phase without geographical significance, and since the high number of rays appears to be a general characteristic of the southern form of the species, it is here proposed to use the name *taeniatus* for that subspecies.

The range of *taeniatus* may then be extended to cover the Atlantic drainage of the Isthmus of Tehuantepec, Guatemala and British Honduras.

Frequency table.—Number of dorsal rays in *Pseudoxiphophorus bimaculatus taeniatus*:

Locality	Authority	Dorsal rays			
		14	15	16	17
Sanborn, Mexico	Hubbs	1	2	..	..
Rio Tonto, Mexico	Regan (1905)	5	7	3	..
San Domingo de Guzman, Mexico	Regan (1905) .....	..	1	..	1
San Domingo de Guzman, Mexico	Regan (in lit.)	1	2	1	..
Belize, British Honduras	Hubbs .....	..	1	..	..

III

Priapichthys annectens Regan

This species as here construed includes two subspecies: typical *annectens*, of the lowland streams on the Atlantic slope of Costa Rica, and the new subspecies *hesperis*, inhabiting the headwaters of the Rio Grande de Tarcoles, a Pacific stream. The form *hesperis*, when compared alone with typical *annectens*, appears to represent a distinct species, but the differences between the two forms are found to be bridged over when one determines the characters of series from Rio Reventazon, which flows down the east slope of Costa Rica opposite these headwaters of the Tarcoles. The connection between the two forms is not by an even areal intergradation, but rather by what may be termed *mosaic intergradation*.

Excluding for the present the intermediate races of the Reventazon basin, the differences between the two subspecies of *Priapichthys annectens* may be expressed as follows:

Character	<i>annectens</i>	Intermediate races	<i>hesperis</i>
Head in length, in adult female....	3.5 to 3.75	3.6 to 4.2, rarely to 4.5	3.8 to 4.35
Eye in head.....	3.0 to 3.7	2.9 to 3.75	3.6 to 4.3
Mouth.....	usually narrower	various	usually wider
Pigment of margins of scale pockets.	tending to form spots	various	less concentrated

Finally, the dorsal rays are reduced in number in the subspecies *hesperis*, as is indicated in the following tabulation:

Frequency table.—Number of dorsal rays in the two subspecies of *Priapichthys annectens*:

	Dorsal rays				
	8	9	10	11	Average
<i>P. a. annectens</i>.....	..	..	22	6	10.21
Intermediate races	1	54	28	1	9.34
<i>P. a. hesperis</i>	3	79	18	..	9.15

Comparison will show that the differences between the *Tierra Caliente* and the mountain forms of *Priapichthys annectens* are rather closely paralleled by the differences which distinguish the races of *Pseudoxiphophorus bimaculatus* inhabiting respectively the same types of environment. Further emphasis will be given this point in a paper to follow the present one.

Priapichthys annectens annectens Regan

Gambusia annectens Regan, Ann. Mag. Nat. Hist., (7) 19, 1907, p. 259; Biol. Centr. Am., Pisces, 1907, p. 97, pl. 14, figs. 5-7.

Priapichthys annectens Regan, Proc. Zool. Soc. London, 1913, p. 992, fig. 170B; Meek, Publ. Field Mus., Zool., 10, 1914, p. 114 (in part).

A series of specimens from Parismina, Costa Rica, taken by Dr. Meek in the Rio Parismina, a lower tributary of the Reventazon, agrees closely with the type-description of *Gambusia annectens* Regan. Hence it is taken as typical of the subspecies *Priapichthys annectens annectens*. The 23 females vary in length to caudal from 18 to 58 mm.; the three males, from 28 to 34 mm. The 6 adult females more than 40 mm. long vary in proportions as follows: greatest depth of body, 3.0 to 3.3; length of head, 3.65 to 3.75; snout, 3.1 to 3.3, longer than eye (but no longer than eye in smaller females, "as long as or shorter than eye," according to Regan); eye, 3.3 to 3.7; scales, 28 to 30; dorsal rays 10 or 11 (ten in 19 specimens, eleven in 6); anal rays, 9, the fin not strongly falcate (except in some young). The coloration consists principally of conspicuous black borders around the scale pockets; the pigment on the ventral part of the scales becoming mostly concentrated to form a round black spot at apex of scale pocket; the spots forming longitudinal rows, somewhat as in *Gambusia*. Along the posterior half of the axial series of scales the black spots become transversely divided, one portion being located above, the other below, the middle of the scale. In some specimens the spots on the scales above and below the axial series have been shifted from their normal median position to a location adjacent to that of the divided spot of the scales of the axial series, which then appear to be bounded above and below by a zig-zag line. On young specimens dark transverse bars extend across the posterior half of the body, passing through every second or third scale of the axial series. In both sexes the bars become faint with age and, in the females at least, completely disappear.

Three half-grown females from Guápiles (spelled Guapilis by Dr. Meek), taken in the Rio Guápiles, an upper tributary of the Rio Negro which flows toward the mouth of the San Juan, agree with the females of the series from Parismina described above. Dorsal, 10; anal, 9.

Priapichthys annectens: races intermediate between *P. a. annectens* and *P. a. hesperis*.

Gambusia annectens Meek, Publ. Field Mus., Zool., 7, 1907, p. 145 (in part).

Priapichthys annectens Meek, Publ. Field Mus., Zool., 10, 1914, p. 114 (in part).

Under this head there are recorded several series of specimens, mostly from the valley of the Rio Reventazon, and all showing traits variously inter-

mediate between those of *P. a. annectens* on the one side and those of *P. a. hesperis* on the other.

1. *Chitaria*; elevation, 340 meters. One female, 48 mm. long to caudal base: depth, 3.3; head, 3.8; snout, 3.4; eye, 3.4; scales, 28; dorsal rays, 9; anal, 9, the fin not strongly falcate. This specimen has the large eye and the coloration of *annectens*, but only 9 dorsal rays, as in *hesperis*, and the head of intermediate length.

2. *El Guayabo*; elevation, 360 meters. Five females, 44 to 56 mm. long to caudal: depth, 3.0 to 3.4; head, 3.6 to 3.9; snout, 3.3 to 3.4; eye, 3.0 to 3.5; scales, 29 or 30; dorsal rays, 10 (four specimens) or 11 (one). These specimens have the large head, large eye, and the number of dorsal rays of typical *annectens*, but the dark margins of the scale pockets are not concentrated into spots.

Another series from Guayabo, collected by J. F. Ferry, contains: (1) young females with the typical coloration of *annectens*; (2) four males, 24 to 30 mm. long to caudal; (3) four females, resembling the lot described above, 42 to 50 mm. long. The adult females present these variations: head, 3.6 to 3.9; eye, 2.9 to 3.2; scales, 29 or 30; dorsal rays, 9 (three specimens), as in *hesperis*.

3. *Turrialba*; elevation, 600 meters. One female, 40 mm. to caudal: depth, 3.4; head, 3.65; snout, 3.0; eye, 3.2; scales, 29; dorsal rays, 9; anal, 9, strongly falcate. This specimen agrees with typical *annectens* in proportions and coloration, but with *hesperis* in the number of dorsal rays.

4. *Tucurrique*; elevation, 941 meters. Four females, 40 to 49 mm. long; head, 3.6 to 4.0; eye, 3.0 to 3.4; scales, 29 to 31; dorsal rays, 9 (all four specimens); anal strongly falcate; dark margins of scale pockets concentrated ventrally into spots, which are not divided along axis of fish. The fishes of this lot have the proportions of *annectens*, but only 9 dorsal rays, as in *hesperis*.

5. *Quebrada de los Negros*; elevation, (?). Twenty-six females, varying in length to caudal base from 34 to 52 mm. The specimens of this lot more than 45 mm. long have the following characteristics: head, 3.8 to 4.2; eye, 3.2 to 3.6; scales, 29 to 31; dorsal rays, 9 (ten specimens) or 10 (16 specimens); anal more or less strongly falcate; coloration as in the Tucurrique lot. The specimens of this series have the large eye characteristic of typical *annectens*, but in the size of the head and in the number of dorsal rays they are intermediate between typical *annectens* and the subspecies *hesperis*.

6. "*Quebradilla*" (this locality cannot be found on the available maps, but according to a note left by Dr. Meek with the specimens, Quebradilla is on the Atlantic slope of Costa Rica). A large series collected by Dr. A. Alfaro, including about fifty males 21 to 29 mm. long. Eight females, 51 to 59 mm. long to base of caudal, have the following proportions: head, 3.8 to 4.5; snout, 2.7 to 3.3; eye, 3.4 to 3.75; scales, 29 or 30; dorsal rays, 8 to 10 (eight in one specimen, nine in 35, ten in 8); anal strongly falcate. This series has the general appearance of *hesperis*, but the eye is not quite so small as in that subspecies.

Priapichthys annectens hesperis, new subspecies

Gambusia annectens Meek, Publ. Field Mus., Zool., 7, 1907, p. 145 (in part).

Priapichthys annectens Meek, Publ. Field Mus., Zool., 10, 1914, p. 114 (in part).

This new form is represented in the collections of the Field Museum of Natural History by a very large series of specimens from San José, Costa Rica, a city on the Rio María Aquilar, an upper tributary of the Rio Grande de Tárcoles (elevation, 1,165 meters); and from Tobosi (1,200 meters); and San Isidro (1,260 meters), on other tributaries of the same stream. Lower in the same basin the species appears to be replaced by *Brachyrhaphis olomina*.

The holotype is a female, 59 mm. long, from San José. Many female paratypes are nearly as large, but the largest male among about 125 is 49 mm. in length, and none of the other males are longer than 36 mm.

Body rather heavy; dorsal contour rather strongly arched before the dorsal fin, its greatest point of elevation being midway between tip of snout and base of caudal (in smaller specimens the dorsal contour is less strongly arched, and its highest point is at the origin of the dorsal fin); the belly is rounded; greatest depth of body in length to caudal base, 2.8 (2.8 to 3.4); caudal peduncle deep, its length from anal fin to base of caudal, 2.8 (2.8 to 3.2) in length of body; least depth of caudal peduncle, 1.35 (to 1.45) in head. The head is short, broad, and deep; its length to end of opercle, 4.3 (3.8 to 4.35) in length of body; its greatest breadth, 1.3 in its length; its depth below occiput, equal to (or a little shorter than) its length. The flatness of the top of the head is continued backward with decreasing width to the dorsal fin; least interorbital width, 1.8 (1.7 to 1.9). Length of the broadly rounded snout, 3.2 (2.8 to 3.3); diameter of the eye, 3.7 (3.6 to 4.3), larger, of course, in smaller specimens. The mouth is oblique and broad, but with well-developed lateral cleft; teeth conic, pointed, in bands, those of the outer series spaced and moderately enlarged.

Scales in 31 (29 to 31) series.

Color in alcohol brownish, becoming lighter on the belly and on the flattened back, but without a definite dark streak along the mid-dorsal line, nor along the axial line of the body, nor along the edges of the caudal peduncle. The scale-pockets are broadly margined with blackish brown except on the under part of the body. In smaller females the scales on the lower part of the body frequently have their pigment concentrated into apical spots, but usually neither so definitely nor so extensively as in *H. a. annectens*; as in that form the pigment of the median three rows of scales tends to be concentrated along the upper and lower margin of the scales of the axial series posteriorly. Small females have dark vertical bars in the posterior part of the body, separated by one or two scales. The dorsal fin is dark, with a row of interradiated black spots near base of fin; caudal dark to light dusky, the scales on its base with conspicuous dark borders; anal and paired fins dusky.

Fins usually smaller than *annectens* proper, but variable. The dorsal is composed of 9, sometimes 10, rarely 8, rays, and its origin is nearly as close to the caudal base as to the head, usually but not always farther back than in *annectens* proper. The caudal is usually short and truncate, as long as (or a fifth longer than) the depth of the caudal peduncle. Anal composed

of 9 rays, the third to the fifth being prolonged to form a short lobe, rendering the edge of the fin strongly falcate; these are the same rays which in the male are much more produced to form the gonopodium; the origin of the anal is midway between the base of caudal and a point behind the eye equal to half or all its diameter. The paired fins are broadly rounded and short, the pectoral being about as long as the postrostral length of the head, the ventrals reaching only two-thirds the distance to the anus or to the origin of the anal fin.

The male, as mentioned before, is much smaller than the female. Its body, while actually not deeper, appears to be so, as the back is more strongly arched; the body is decidedly more compressed; the width of the head is contained about 1.6 times in its length. The proportions are like those of the young females, or like the adult females of *annectens* proper. The coloration and color range agree with those of the female. The dorsal fin is inserted midway between the base of the caudal and the anterior half of the postorbital length of the head; the origin of the anal midway between base of caudal and tip of mandible; the ventral fins extend to the origin of the anal.

The gonopodium (intromittent organ) is elongate, reaching when depressed nearly to the lower procurrent rays of the caudal fin. Its finer structure is like that of *annectens* proper. The organ is developed from the third, fourth, and fifth anal rays when the fish has reached a length of about 20 mm. to caudal. Over one hundred males were examined with the organ developed; in length these specimens vary from 21 to 49 mm., few being more than 30 mm. long, and only the largest being longer than 36 mm. In the specimens from 21 to 36 mm. long the serrae-bearing segments of the second produced ray vary in number from 8 to 12, averaging fewer in the smaller specimens than in the larger ones; in the largest male (49 mm. long) the number is increased to at least 18. The number of serrae doubtless increases with age, as might well be expected, for one serra is developed from each of the distal articulations of the ray, and the number of articulations, of course, increases with age.

EXPLANATION OF FIGURES

All of the figures are of gonopodia, the intromittent organ formed by the modification of rays 3, 4 and 5 of the anal fin in the male. In each figure the rays are numbered, and if divided the anterior (a), median (m) and posterior (p) branches of each ray are lettered as indicated; further, the left (l) and right (r) halves of certain branches are also shown, and so lettered. The gonopodia are all shown as semitransparent objects, and all, with the exception of that of *Pocciliopsis lutzi* (figure 3) are viewed from the left side. All the figures were drawn with the aid of a projection machine in order to secure accuracy of proportions; detailed corrections of the outlines of individual segments were made while the object was being examined under a high power of the microscope.

PLATE I

Figure 1. Distal portion of gonopodium of *Gambusia puncticulata*, from a specimen 26 mm. long to caudal fin, from Havana, Cuba. The terminal hooks of rays 4 and 5 are indicated by the letters *t h*.

Figure 2. Distal portion of the gonopodium of *Heterandria formosa*, from a specimen 12.5 mm. long to caudal fin, from De Leon Springs, Florida.

GONOPODIA OF POECILIDAE

PLATE I

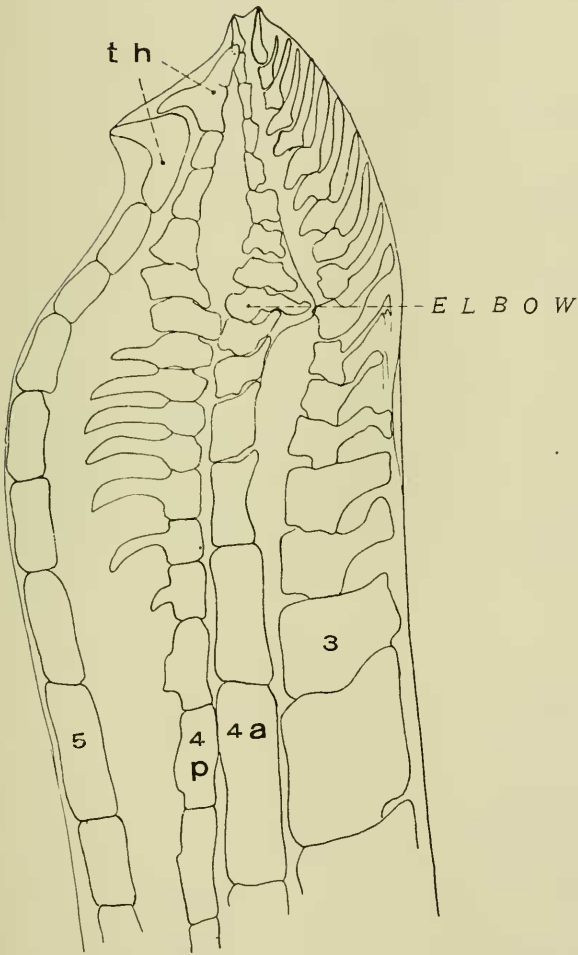


FIGURE 1

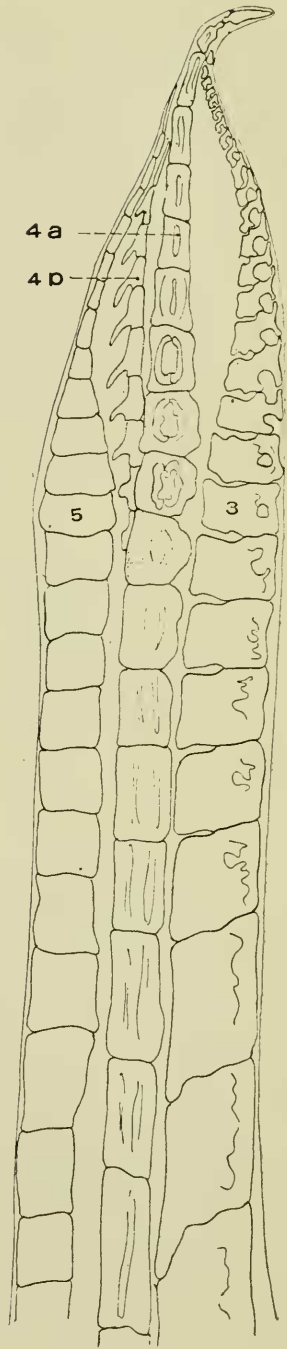


FIGURE 2

PLATE II

Figure 3. Distal portion of the gonopodium of *Pociliopsis lutzii*, from a specimen 26 mm. long to caudal fin, from San Juan, a village in Acayucan, Mexico. Figure *A* shows the right side of the gonopodium, while figures *B* to *F* digrammatically show in oblique views, the cross-cut ends of the gonopodium at various indicated levels; the latter are introduced to show the complex imbrication of the rays to form a tube, and the bilateral asymmetry of the two halves of certain rays. The crescentic horn in the membranous tip of the gonopodium is indicated by the letters *ch*.

GONOPODIA OF POECILIIDAE

PLATE II

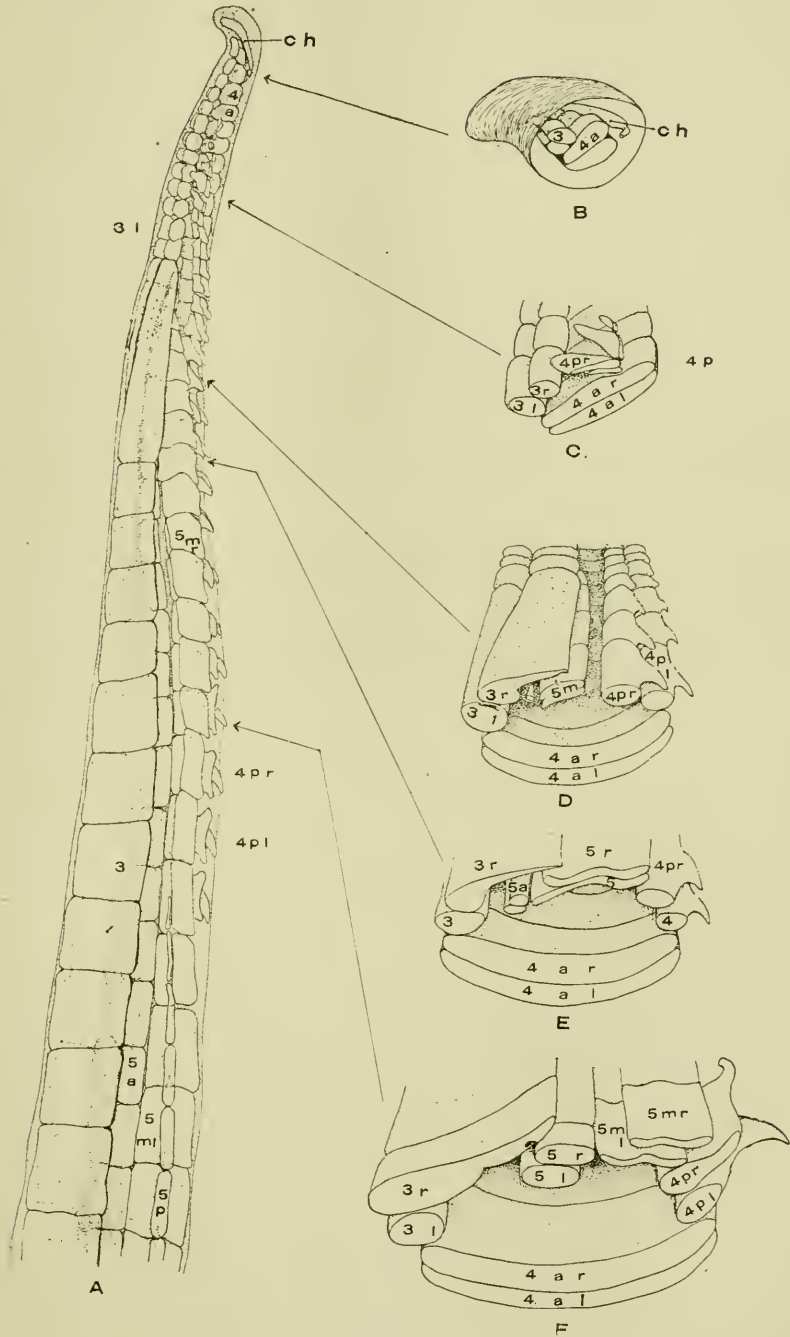


FIGURE 3

PLATE III

Figure 4. Distal portion of the gonopodium of *Platypoecilus maculatus*, from a specimen 23 mm. long to caudal fin. The membranous hook is labelled *m h*.

Figure 5. Distal portion of the gonopodium of *Neopoecilia holacanthus*, from a specimen 34.5 mm. long, from Arroyo, Porto Rico. The prepuce-like hood in this and the following two figures is indicated at *p h*.